Understanding Our Changing Planet
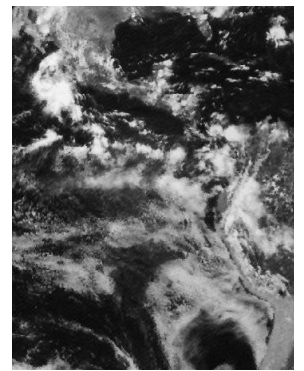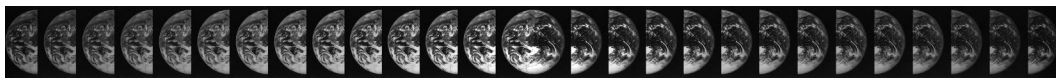
**Earth Science Enterprise
1998 Applications Fact Book**

NASA

Contents

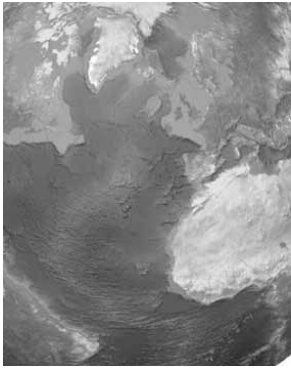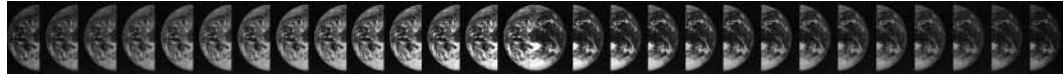# Understanding Our Changing Planet

Earth Science Enterprise
1998 Applications Factbook

National Aeronautics and
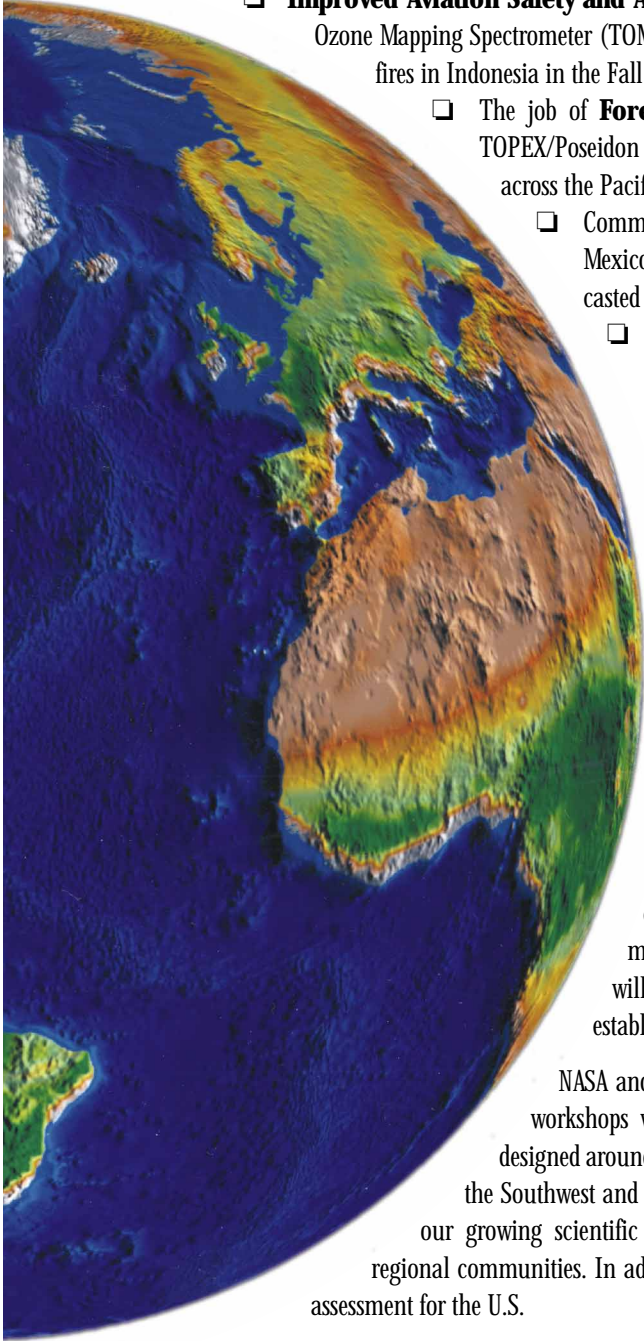Space Administration

Introduction

The goal of NASA's Earth Science Enterprise is to understand the effects of natural and human-induced changes on the global environment. The unique vantage point of space provides information about Earth's land, atmosphere, ice, oceans, and life that could not be gathered in any other way. Data returned by satellites, expanded by data from aircraft, balloons and ground-based platforms, give public and private resource managers the scientific understanding they need to craft sound environmental policies and make informed economic decisions for the future.

We understand some facets of our environment fairly well, such as short-term weather forecasting, basic hurricane tracking, and detecting changes on the Earth's surface. We are developing the data and scientific understanding that we need to predict how the climate will shift on longer time frames, and what the effects will be on people whose livelihoods depend on that climate - farmers, fishermen, foresters, and urban planners, are a few examples.

As the data and knowledge grows, the opportunity to affect the broad spectrum of the public is increasing at a significant rate. The ***1998 Earth Science Enterprise Applications Fact Book*** presents 11 examples of innovative applications that are using Earth Science data and technologies to understand and respond to changes in our environment.

❏ "**The GreenReport**," a series of weekly satellite-derived map sets showing crop and vegetation condition, progress, and change within the U.S., is currently benefiting the agricultural community, insurance industry and forestry businesses.

❏ **The Satellite Fire Potential Index** estimates surface greenness, to aid researchers and Fire Management Officers in several National Forests.

❏ Mining in Leadville, Colorado, has produced waste drainage which is being remediated by several Federal agencies, contractors, and responsible parties through use of a **Mine Drainage Mapping** project.

❏ A network of Global Positioning System (GPS) receivers, known as the **Southern California Integrated Global Positioning System Network (SCIGN)**, is being installed throughout the Los Angeles Basin to provide better estimates of earthquake hazards and to more effectively support emergency response during earthquake recovery efforts.

❏ Earth science research has produced a Version 1 **Surface Solar Energy (SSE)** data product that is aiding placement of solar-powered lighting, cooking and water purification equipment in refugee camps.
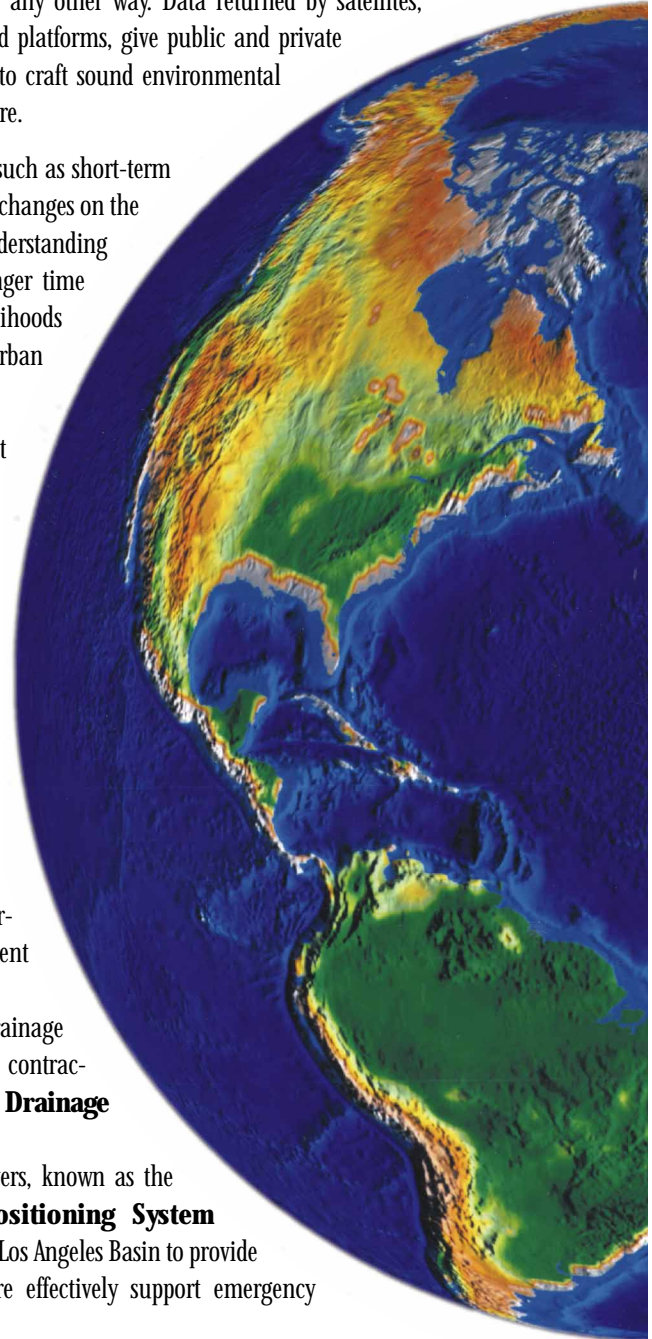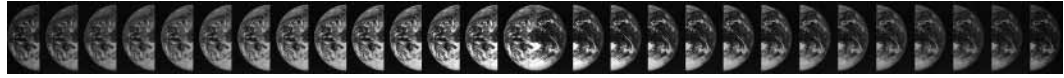
❑ Global hydrologists and climate researchers are studying how "urban forests" can reduce summer cooling costs in dense population centers, known as **Urban Heat Islands**, in Atlanta, Georgia.

❑ **Improved Aviation Safety and Air Pollution Tracking** are made possible by NASA's Total Ozone Mapping Spectrometer (TOMS), which also monitored extensive smoke plumes from the fires in Indonesia in the Fall of 1997.

❑ The job of **Forecasting the 1997 El Niño** was made easier by the TOPEX/Poseidon satellite, which tracked the movement of the phenomenon across the Pacific.

❑ Commercial fishermen and the oil drilling industry in the Gulf of Mexico both benefit from assimilations of current eddy activity forecasted by the **"Nowcast"/Forecast System** model.

❑ **Sea SurfaceTemperature Maps** are measuring water temperatures, movement and currents along the North American coasts to help the maritime and sport fishing industries.

❑ **WorldWinds** products are being used by television stations along the coastal U.S. to assess weather conditions, such as hurricanes, nor'easters, and offshore marine winds.

As we move into the Earth Observing System era, the Earth Science Enterprise is pursuing a broader range of applications efforts in partnership with industry, state and local governments, and other Federal agencies. The Stennis Space Center will lead efforts with industry to define and develop new markets for remote sensing data. This Fall, five Regional Earth Science Applications Centers comprising private/public consortia will be selected to implement innovative applications meeting regional needs. These will complement the Regional Applications Centers already established by universities around the nation with NASA's help.

NASA and its partner agencies are co-sponsoring a series of regional workshops with regional partners around the U.S. Each workshop is designed around a theme important to that region, such as water resources in the Southwest and agriculture in the upper Midwest. They serve to identify how our growing scientific understanding can be applied to practical challenges in regional communities. In addition, the regional workshops will culminate in a national assessment for the U.S.

Earth Science is truly science in the national interest. NASA's research results and its many partnerships with industry, universities, and regional governments put practical information and tools to work for the public.
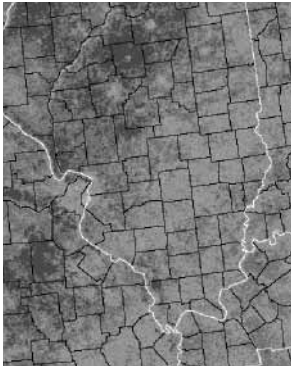
Satellite-Derived Vegetation Maps for the Agriculture and Forestry Industry: The GreenReport

User Need:

The Agricultural and Forestry Industries need timely and continuous information regarding crop/vegetation progress and condition. The Kansas Applied Remote Sensing (KARS) Program at the University of Kansas, with support from NASA's MTPE Science Applications Program, produce a weekly map set known as the GreenReport, which illustrates crop/vegetation condition, progress, and change within the conterminous United States. Users include the commodity business, grain traders, seed buyers, range managers, crop insurance providers, and forestry industries.
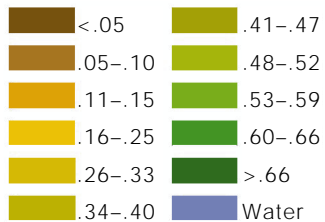
Product:

The GreenReport features four maps produced from 1km AVHRR satellite composites. The maps show vegetation greenness values, illustrate the changes in vegetation from week to week, compare the current period to the same period in the previous year, and compare the current period to the previous seven-year average. GreenReport map sets are sent each week to users electronically by The Data Transmission Network, Omaha, NB; the WeatherExpress FTP site, Omaha, NB; the FutureSource Internet site; Lombard IL; and the Agribiz Internet site, Normal, IL. Shown is an annotated Cornbelt Greenness Map.

Utility/Benefit:

Maps produced from remotely sensed data can provide critical information in a timely manner on the health and vigor of vegetation, information that is important to resource managers in the agricultural and forestry industries. In addition, satellite data can better illustrate vegetation/crop progress and conditions on a continuous basis, while greatly improving current crop reporting techniques. For example, the Chicago Board of Trade is consistently using the Green Report to forecast agricultural commodity projections. GreenReport data sets will also be made available to research scientists.

For more information, visit: http://www.jkars.ukans.edu

KARS

<.05	.41–.47
.05–.10	.48–.52
.11–.15	.53–.59
.16–.25	.60–.66
.26–.33	>.66
.34–.40	Water

**Vegetation Index
Greenness Map**

Cornbelt
July 19–August 1, 1996
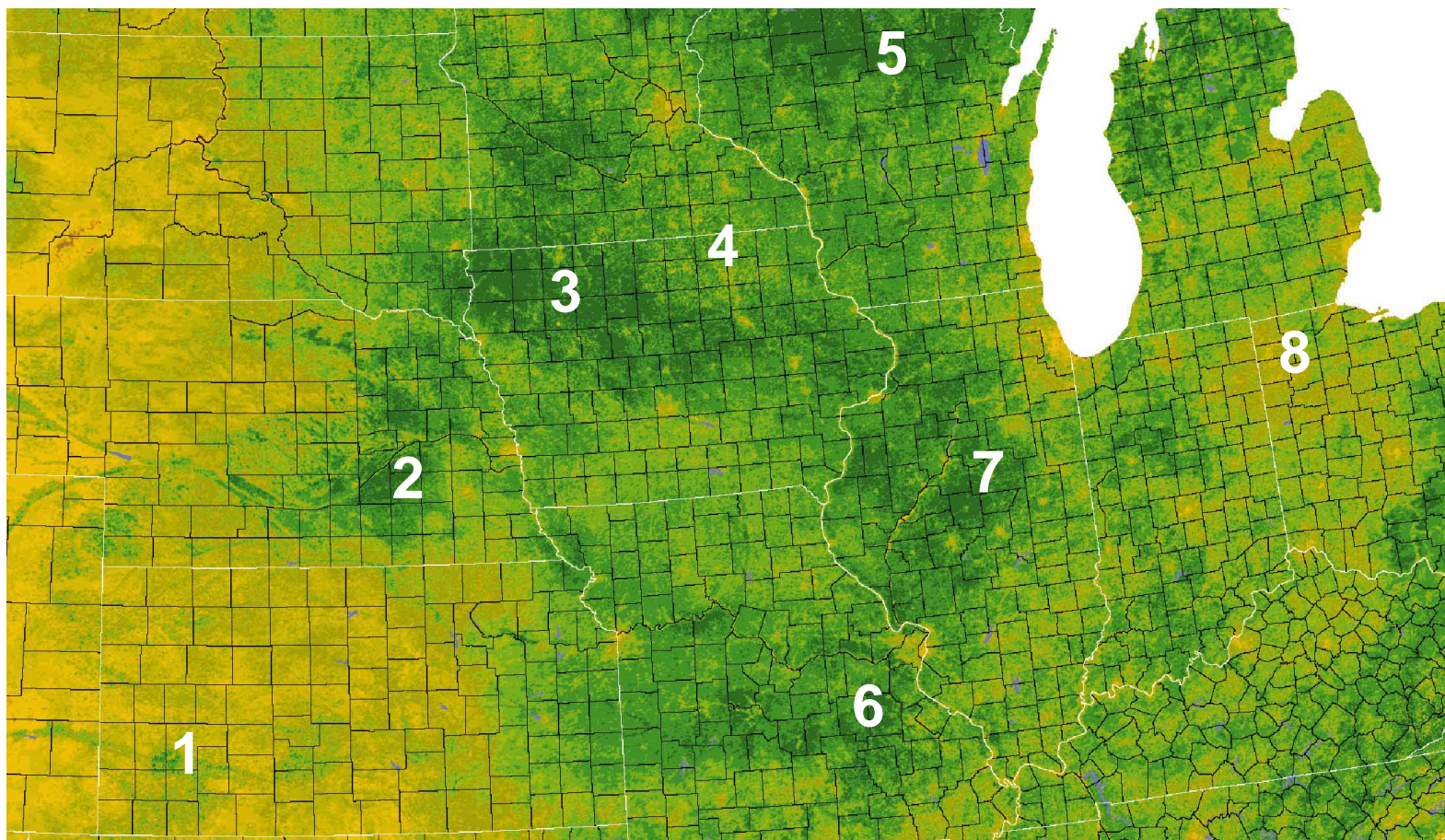
1. Irrigated crops in Kansas
2. Corn in Nebraska at peak greenness
3. Iowa crop development most advanced in northwestern part of State
4. This area of Iowa was dryer than the western part of the State
5. High greenness values in Wisconsin forested areas
6. High greenness values in Missouri forested areas
7. Good crop development in central Illinois
8. Crop development in the eastern cornbelt two to three weeks behind normal
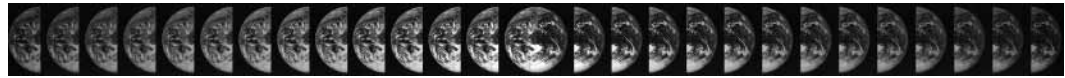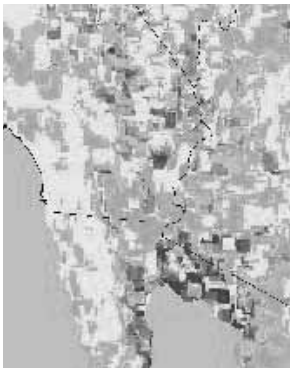
Satellite Fire Potential Index

User Need:

In 1996, 88,000 wildfires burned over 6 million acres at a cost of over $1 billion in suppression activities. If you factor in the role of prescribed fires, which accounted for an additional 0.5 million acres burned in 1996, the impact of fire becomes apparent.

There are two primary Forest Service user audiences; the first is the Research Branch of the Service who is developing updates to the National Fire Danger Rating System (NFDRS). The NFDRS currently uses AVHRR-derived Normalized Difference Vegetation Index (NDVI) data to estimate surface greenness as part of a bi-weekly monitoring effort. However, this prototype model provides not only a stronger biophysical product than the NDVI, but it is also provided at higher temporal resolution. The second Forest Service audience is the National Forest System. Researchers are applying the images to updating strategic planning and assessment efforts, while the individual forests can apply the images to tactical efforts. The number of potential users in the tactical community includes all National Forest FMO's who can access the imagery as an improvement to current assessment tools.

Additional user audiences may be developed through the Upper Midwest Aerospace Consortium as other value-added products are derived from the Fire Danger product. A derivative product termed "Satellite Drought Index (SDI)" is under development.
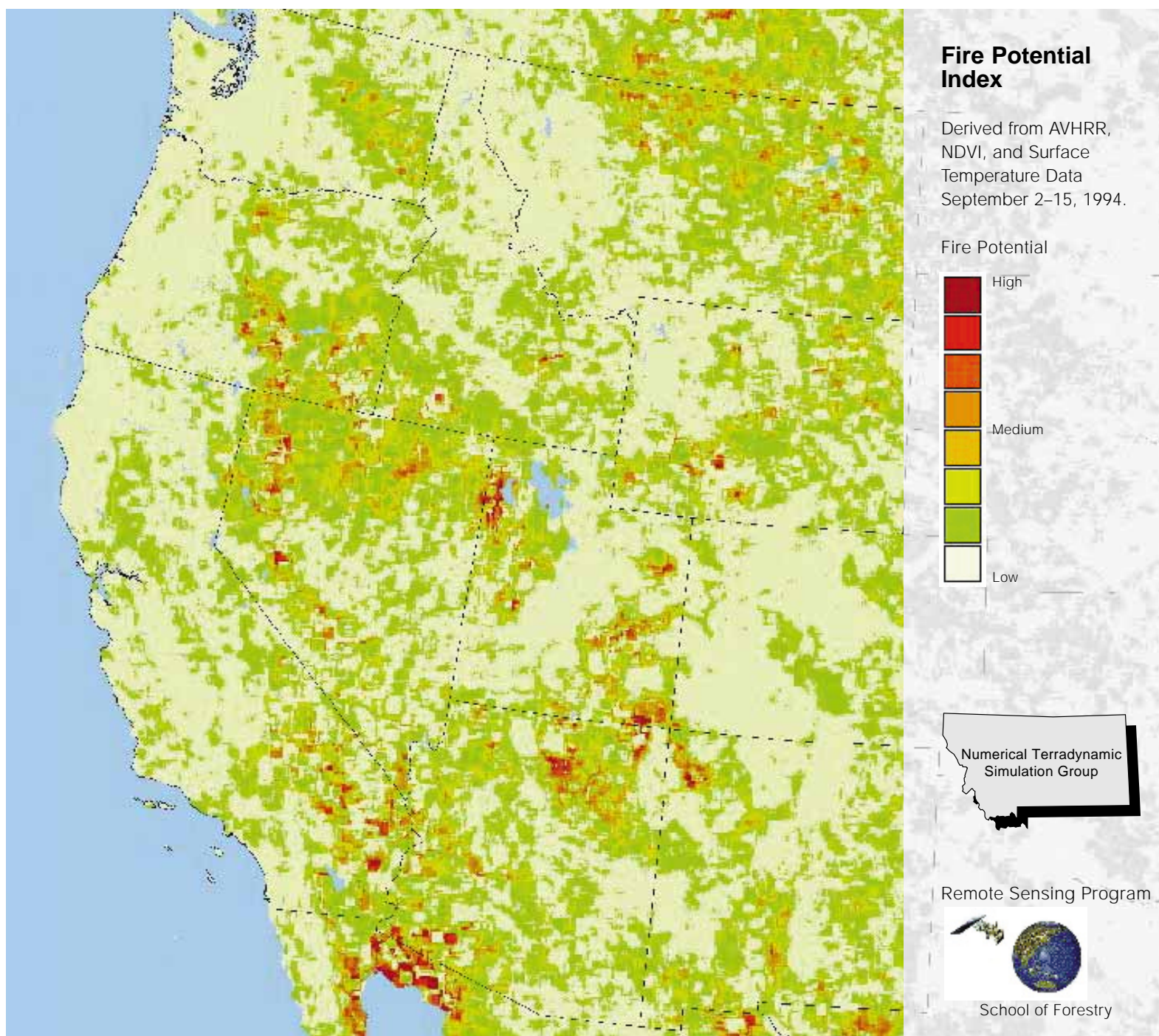
Product:

A Moderate-Resolution Imaging Spectroradiometer (MODIS) prototype program based on surface resistance logic has been completed and is now producing values for a Satellite Fire Potential Index, which is a prototype model for the future MODIS terrestrial science product, beginning with the operation of the instrument in 1998. The current sequence of AVHRR-based products will provide essential historical or pathfinder information for cross-validation of the MODIS product. The prototype algorithm is being run on weekly Advanced Very High-Resolution Radiometer (AVHRR) data sets made available by the U.S. Geological Survey's EROS Data Center. The images are being generated for the eleven western states, one time per week (some composite periods allow continental coverage). The posted images are coded with a standard legend that identifies levels of fire potential. The Satellite Fire Index is mapped using two primary inputs: (1) fraction of vegetative cover/leaf area index as depicted by Normalized Difference Vegetation Index (NDVI), and (2) surface temperature. Both inputs are calculated from AVHRR data and then regressed to estimate fire potential. Stress values are then scaled, with high levels of moisture stress coded to represent higher fire index values.

Development of the working prototype model has been a collaborative effort of three organizations. The University of Montana Numerical Terradynamic Simulation Group (NTSG) MODLAND Science Team has conducted the research and development of the model using NASA support. Additional support has been provided by scientists at the U.S.D.A. Forest Service Intermountain Fire Sciences Laboratory in Missoula, MT, and by the Upper Midwest Aerospace Consortium.
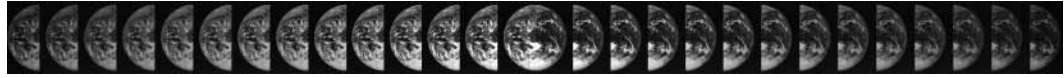
Utility/Benefit:

An accurate means of estimating the potential for forest fire outbreaks would be a great boon to forestry management. NASA sponsored researchers at the University of Montana have developed such a means; using satellite

Fire Potential Index

Derived from AVHRR, NDVI, and Surface Temperature Data September 2–15, 1994.

Fire Potential

High

Medium

Low

Numerical Terradynamic Simulation Group

Remote Sensing Program

School of Forestry

data, they have invented a fire potential index. The benefits of the MODIS-type prototype fire potential index are twofold: *Short-term economic effects*. In the short run, defined as a single fire season, satellite information has the potential to improve management decisions at a tactical level with respect to individual fires. This includes ignition, fire behavior, suppression and/or monitoring, all of which result in physical and financial damage. *Long-term economic effects*. The potential future economic benefits would be manifested in policy change and improved organizational efficiency. Total cost and damage would be expected to decrease in the long run as a result of enhanced strategic decisions.

For more information, visit: http://www.forestry.umt.edu/NTSG/projects/regional

Mine Drainage Mapping in Leadville, Colorado

User Need:

The Leadville mining district, located at an elevation of 3000 m in the Central Colorado Rockies, has been mined for gold, silver, lead and zinc for over 100 years. This activity has resulted in waste rock and tailings, rich in pyrite and other sulfides, being dispersed over a 30 sq. km area including the city of Leadville. Oxidation of these sulfides releases lead, arsenic, cadmium, silver, and zinc into snowmelt and thunderstorm runoff, which drains into the Arkansas River, a main source of water for Front Range urban centers and agricultural communities. The sulfide mineral pyrite is a primary source of acid drainage. The U.S. Environmental Protection Agency (EPA), U.S. Bureau of Reclamation (USBR), contractors, and responsible parties are remediating the mined areas to curtail further releases of heavy metals into various drainage tributaries of the Arkansas River.
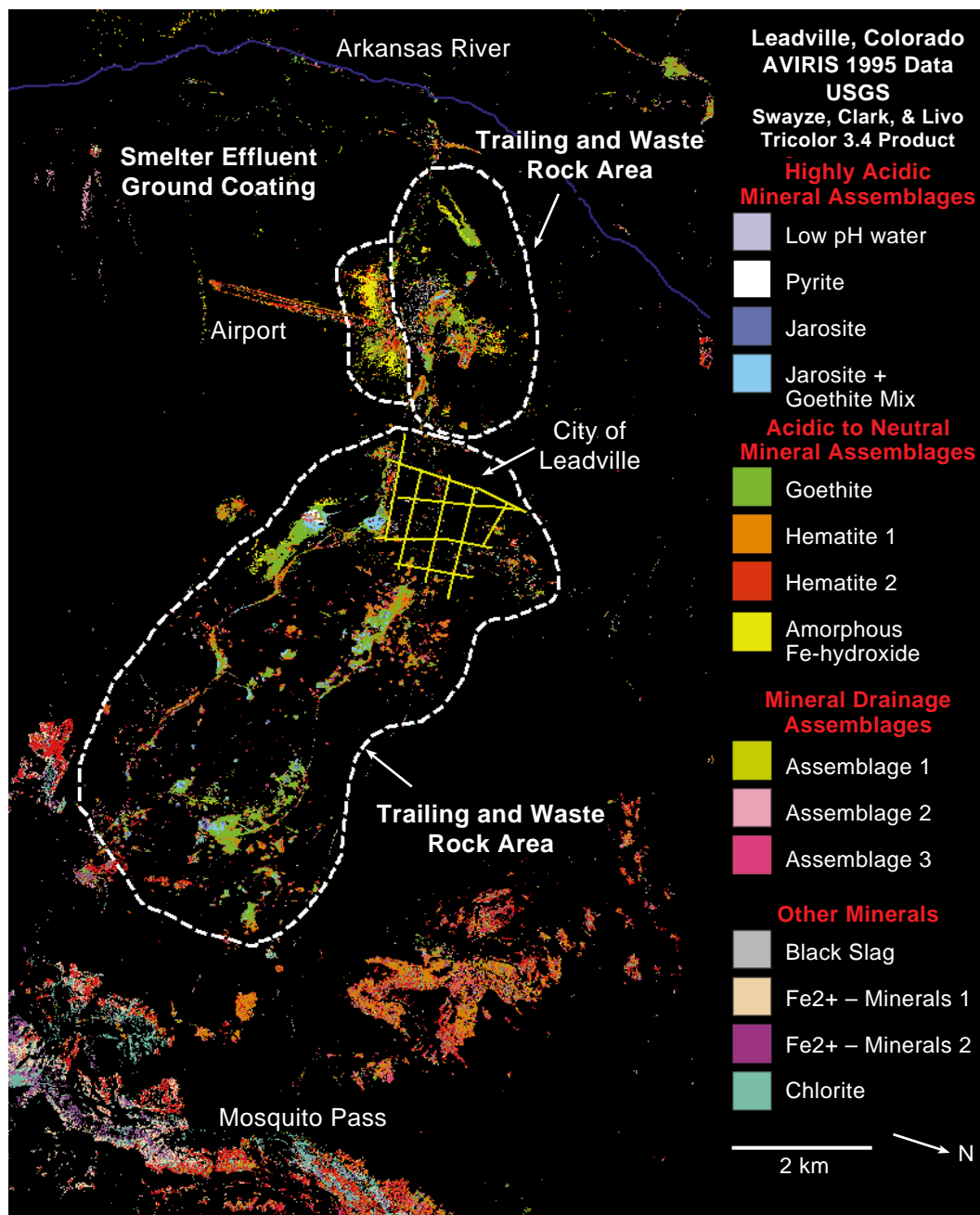
Product:

Airborne Visible and Infrared Imaging Spectrometer (AVIRIS) data was collected over Leadville on 27 July 1995 as part of the NASA Shuttle Imaging Radar-C (SIR-C) Data Integration Project with USGS. Calibrated reflectance data was spectroscopically mapped using the Tricorder algorithm. Tricorder is an expert system which is capable of simultaneously analyzing spectra of solids, liquids, and gases; it can preprocess data, then do an initial analysis, and from this decide on a number of alternate analysis paths.
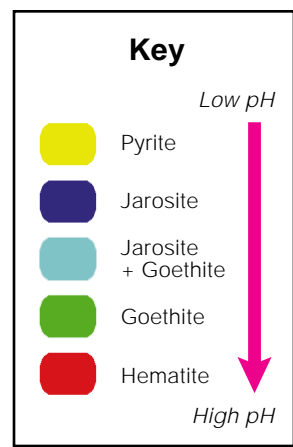
Utility/Benefit:

The mineral maps created from AVIRIS data are being used to guide the U.S. Bureau of Reclamation's investigation, characterization, and remediation efforts for the EPA at the California Gulch Superfund National Priority List site. Based on the pattern of secondary oxidation-weathering minerals that form above pyrite-rich waste rock and tailings, a map of the electronic absorption spectral region can be used to locate potential sources of acid mine drainage. Those areas covered by jarosite and jarosite-goethite mine-waste are believed to have a high acid generating capacity and are surface point-sources for acid water and heavy metals. Areas covered by goethite and hematite can still contain heavy metals (absorbed on or as components of the secondary minerals), but they will not be mobile in the absence of low pH water, normally found in the jarosite-rich areas. It is possible that the minerals at the surface of the waste piles and tailings may not reflect the pile's composition at depth. Depending on the amount of precipitation and level of the groundwater table, unoxidized sulfides may be hidden by a layer of non-acid generating secondary minerals. In these cases, surface mineral maps will not show the acid-generating capacity of the waste rock and tailings beneath the surface. As part of the ongoing investigation, USBR plans to correlate surface mineralogy with soil metal-concentration and pH information from drill cores and geoelectrical profiling, to better address this possibility. Significant cost savings in investigation and remediation design have already been realized using AVIRIS data at this National Priority List Site.

For more information, visit: http://www.speclab.cr.usgs.gov

Leadville, Colorado AVIRIS 1995 Data USGS Swayze, Clark, & Livo Tricolor 3.4 Product

Arkansas River

Smelter Effluent Ground Coating

Trailing and Waste Rock Area

Airport

City of Leadville

Trailing and Waste Rock Area

Mosquito Pass

Highly Acidic Mineral Assemblages
- Low pH water
- Pyrite
- Jarosite
- Jarosite + Goethite Mix

Acidic to Neutral Mineral Assemblages
- Goethite
- Hematite 1
- Hematite 2
- Amorphous Fe-hydroxide

Mineral Drainage Assemblages
- Assemblage 1
- Assemblage 2
- Assemblage 3

Other Minerals
- Black Slag
- Fe2+ – Minerals 1
- Fe2+ – Minerals 2
- Chlorite

2 km   N

Idealized Acid–Mineral Assemblage Bull's Eye

Image

Key

Low pH

- Pyrite
- Jarosite
- Jarosite + Goethite
- Goethite
- Hematite

High pH

Idealized Acid-Mineral Assemblage Bull's Eye. Secondary minerals form roughly concentric zones around pyrite-rich areas at the surface. These patterns can be used to locate point-sources of acid mine drainage at Leadville and probably at other mined and unmined areas by marking areas of low pH and potential trace metal mobility.

Leadville iron-bearing mineral map. Map of the mineral distribution of the waste rock and tailings piles at the California Gulch Superfund Site near Leadville, Colorado (130 km SW of Denver). Each color identifies iron-bearing minerals in each 17 by 17 meter square area (pixel) on the ground. Blue colors show minerals which cause acid mine drainage high in dissolved metals, such as cadmium, zinc, and lead. Areas in green have minerals that are more neutral, but are still of concern. Other colors are minerals not contributing to water contamination. No iron-bearing minerals were found in areas shown in black. The area shown is 10.5 km wide and 17 km long. North is toward the lower right of the image.
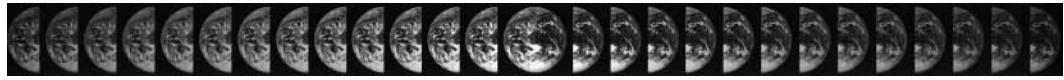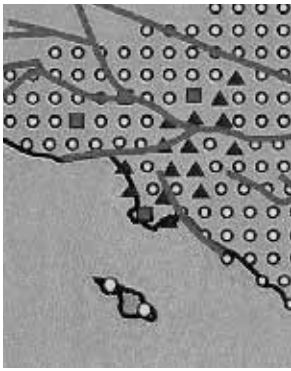
Southern California Integrated Global Positioning System Network (SCIGN)

User Need:

A significant element of NASA's Natural Hazards Research and Applications Program focuses on seismic hazards in Southern California. NASA is the largest partner in a joint Federal-state-private foundation effort to establish a dense array of ground-based GPS receivers in the Los Angeles basin designed to measure movements in the Earth's crust very precisely. The cost effectiveness of this new GPS technology is being demonstrated in Southern California where NASA, NSF, USGS, and the Keck Foundation are supporting the development of the Southern California Integrated GPS Network (SCIGN). SCIGN is a network of 250 GPS receivers which will continuously monitor motion along faults and other land surface deformation to provide better estimates of earthquake hazards and to more effectively support emergency response during earthquake recovery efforts.
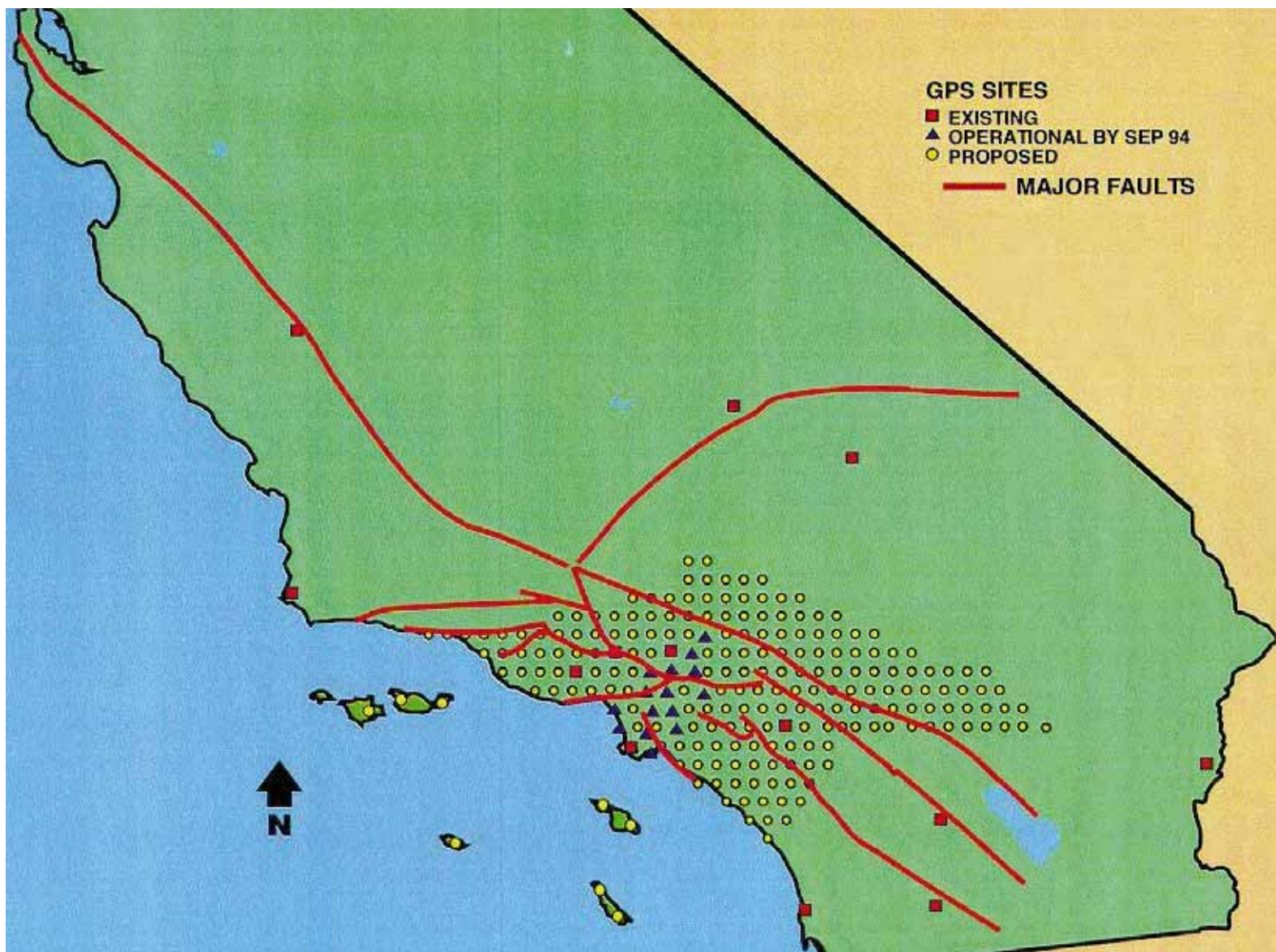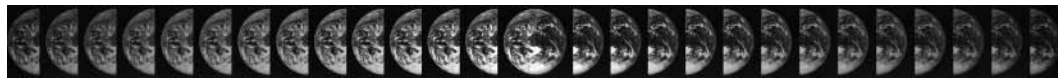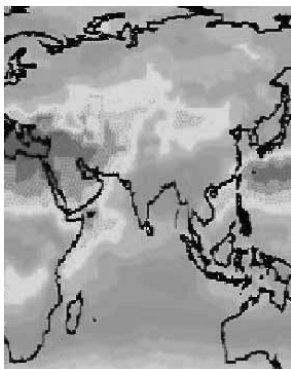
Product:

The GPS satellites bathe the Earth with a precisely maintained radio signal. SCIGN receivers use the signals from four or more of the 24 orbiting GPS satellites to position themselves in space and time. GPS was developed by the Department of Defense as an all-weather navigation system capable of positioning a vehicle within an uncertainty of 4 meters—about the size of a comfortable room. NASA has applied the technology to earthquake and crustal motion applications.

Utility/Benefit:

SCIGN is a valued spacebased resource which is providing improved efficiency, reliability, and safety for ground and spaceborne operations. NASA's Earth Science program is developing new and innovative techniques to use the SCIGN system and its signal structure, and is working with the DoD to design improvements in the next generation SCIGN system to meet the challenges of the next millennium. The new GPS receivers are so accurate that researchers are now able to continuously measure the inexorable motion of the continents as they move an inch or so per year, with respect to each other, due to the slow seafloor spreading process occurring beneath the oceans. As this plate tectonic process continues it generates stresses at the boundaries between tectonic plates such as the West Coast of the U.S., unleashing earthquakes and volcanic eruptions.

For more information, visit: http://www.milhouse.jpl.nasa.gov

GPS SITES
- ■ EXISTING
- ▲ OPERATIONAL BY SEP 94
- ○ PROPOSED
- —— MAJOR FAULTS

N

Surface Solar Energy Measurements

User Need:

Forty percent of the Earth's population has no electricity. In these areas of the World where many currently spend the entire day searching for fuel. The use of solar power for cooking can reduce the incidence of respiratory diseases from wood and kerosene smoke and fumes, a leading killer of women. The designers of these projects look to NASA to provide detailed information about the amount of solar energy falling on the Earth's surface. Companies investigating the many commercial applications of solar-powered systems also look to NASA to supply highly accurate global solar energy data.

Product:

With help from Earth Science Enterprise (ESE) science data, solar power is being harnessed to supply basic needs for many of these people cheaply and efficiently. Three of the five ESE science priority areas are concerned with energy and/or the environment at the Earth's surface. A Version 1 Surface Solar Energy (SSE) data product has been created using historical satellite data by Langley Research Center in cooperation with the U.S. Department of Energy (DOE).

The accuracy of this initial product meets the needs of many humanitarian and small-scale electrical-generation projects. Similar SSE data from future EOS satellite systems will be more precise and can be used for final design of large-scale solar and solar-assisted power plants, and for advanced commercial solar power technologies. The SSE data can also be used to support improved global agricultural practices.

Utility/Benefit:

The existing Earth Science program Version 1 SSE data has been used to negotiate placement of solar-powered cooking and water purification equipment in refugee camps by Solar Cookers International. Using SSE data, Sun Frost developed a much improved solar-powered vaccine refrigerator for operation in remote tropical regions. The Boeing Co. plans to use the data for determining regional placement of solar power plants in other countries. Solar Energy International is one of several organizations taking steps to include the SSE data in their solar energy design software. The SSE solar radiation maps are being made available to the Francophone Institute of Energy (IEPF) for inclusion in a book on solar pumping. Other organizations have requested additional information concerning both the Version 1 product as well as future Earth System satellite data products for use in the power-generation and agricultural industries.
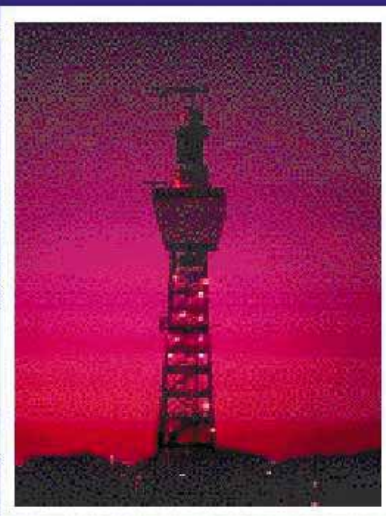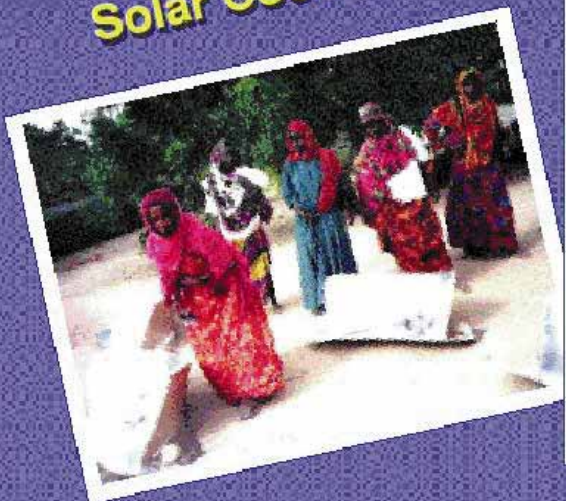
For more information, visit: http://www.eosweb.larc.nasa.gov

Solar Energy at the Earth's Surface for July

High

Low

Solar Power Towers
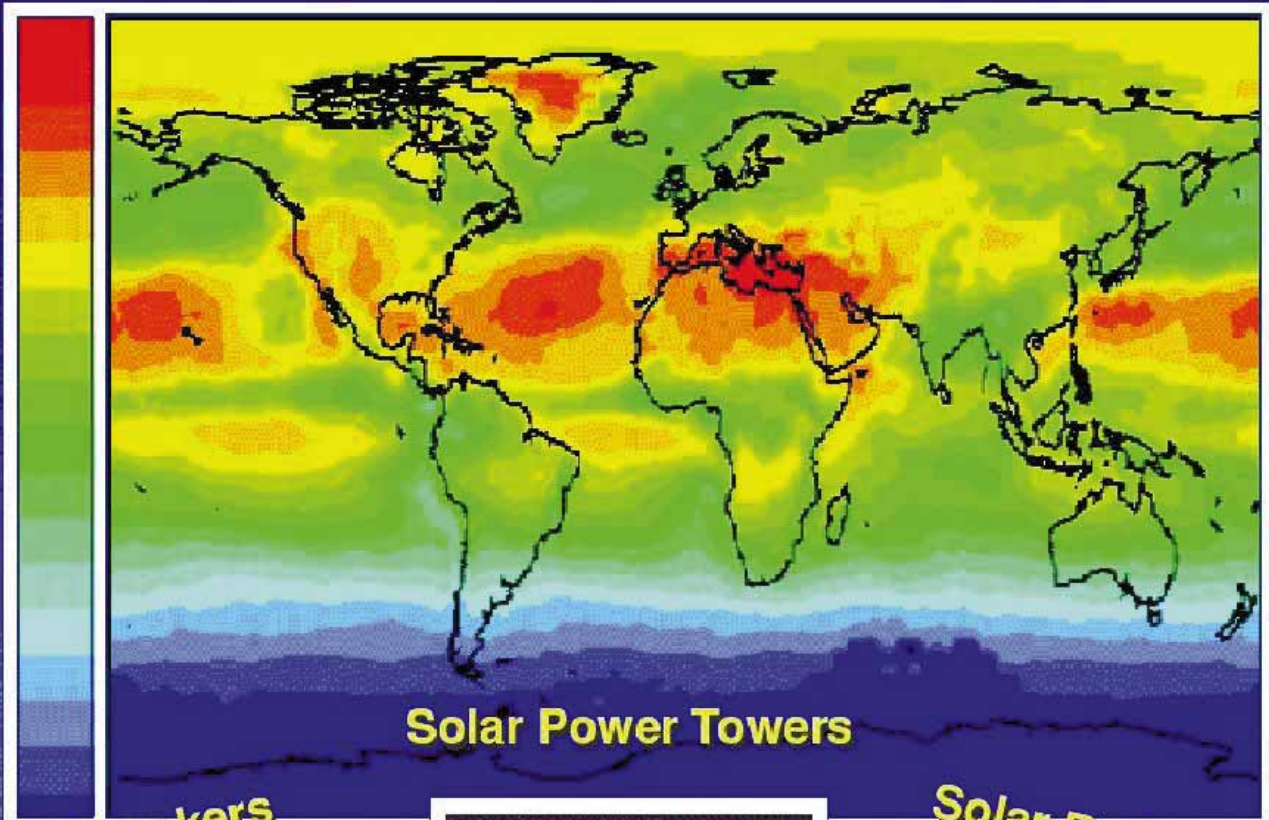
Solar Cookers
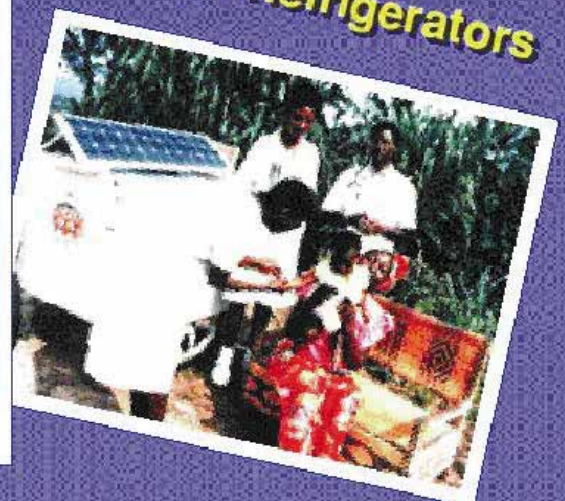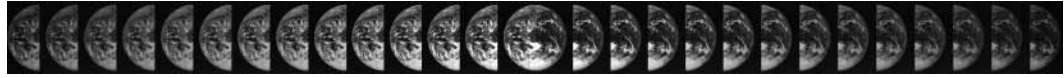
Solar Refrigerators

http://eosweb.larc.nasa.gov/DATDOCS/Surface Solar Energy.html

Urban Heat Islands
in Atlanta, Georgia

User Need:

Urban heat islands result when naturally vegetated surfaces are replaced with asphalt, concrete, rooftops and other man-made materials. Findings indicate that artificial surfaces can be 20 to 40 degrees higher than vegetated surface temperatures, as materials such as asphalt store much of the sun's energy and remain hot long after sunset. This produces a "dome" over the city of temperatures 5 to 10 degrees higher than air temperatures over adjacent rural areas.

In findings from similar studies, researchers found that city parks and other urban areas with trees and grass were cooler than parking lots and areas with a high concentration of buildings. Thermal views of Atlanta demonstrate that the warmer the city becomes, the greater the peak demand on power plants, which must utilize fossil fuels to a greater extent, which ultimately has a negative impact on air quality.

Product:

Global Hydrology and Climate Center (GHCC) researchers at NASA's Marshall Space Flight Center (MSFC) are studying Atlanta, Georgia, in an effort to learn how rapid urbanization affects temperature and air quality. The objective is to find out what can be done to lessen the impact of "urban heat islands," bubble-like accumulations of hot air, that have developed as Atlanta has grown during the past 20 years.

GHCC is studying how "urban forests" may allow cities to continuously grow while maintaining air quality and the environment, and also lower cooling costs during sweltering summer months. Atlanta's hot spots were determined by a Lear Jet equipped with thermal imaging equipment which flew over the metropolitan area during May 1997, taking heat images at mid-day at peak heat, and again 12 hours later when surfaces began to cool.
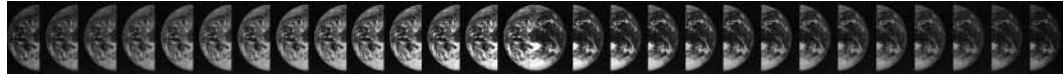
Utility/Benefit:

GHCC scientists are studying the effect of tree cover on Atlanta's temperature and air quality. Atlanta's urban planners can use the findings to determine the benefits of developing and maintaining urban forests. Power requirements could be reduced with building plans that incorporate trees to shade roofs, which would reduce the heat load on houses and buildings.

For more information, visit: http://www.ghcc.msfc.nasa.gov

Daytime thermal image of the Atlanta central business district area

shades of red	Vegetation
blue-green	Man-made surfaces typical of the city landscape
white	Rooftops
black	Shadows
dark grey	Road surfaces
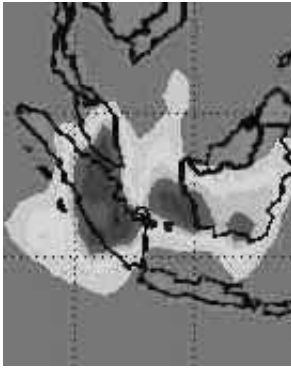
Improving Aviation Safety and Air Pollution Tracking with Total Ozone Mapping Spectrometer (TOMS)

User Need:

Volcanic clouds and high levels of atmospheric aerosols can cause engine stoppage in flight and extensive damage to the airframe, windows and sensors of large jet aircraft. So far, emergency landings have been successful, although repairs to the aircraft have cost up to $80 million. At least 15 aircraft have been damaged in North Pacific routes alone since 1980. More than 20 others were damaged in the eruption of Mt. Pinatubo in 1991.

Product:

Real-time and near real-time satellite data on the presence of volcanic ash with warnings on potential hazards to aircraft using the NASA TOMS instrument data are available to the aviation industry for the first time through a joint NASA/NOAA agreement. TOMS data has also detected smoke from the Indonesian fires starting in mid-August through mid-October. Because of the lack of strong winds over Indonesia, the smoke patterns have been very stationary. Major fire sources of smoke are clearly seen in the Indonesian Archipelago Islands of Sumatra, Borneo, and new Guinea, and smoke from smaller fires are seen over Malaysia. TOMS data indicates very high smoke optical depths of 7 to 10 in the UV, virtually eliminating the UV-flux at the ground. Recent studies indicate that the elimination of UV for significant periods can have a strong negative biological impact on the environment.

Utility/Benefit:

TOMS images of aerosol extinction following the Indonesian fires during Fall 1997 demonstrate the instrument's ability to provide an accurate tracking of aerosol development and extinction. The data can be used to detect the presence of aerosols (smoke, dust, volcanic ash, and industrial pollution) in the Earth's atmosphere over both land and water. These aerosols can be clearly distinguished from clouds and detected over land. The aviation industry is using this data to alert military and commercial aircraft to potential hazards from volcanic ash.

TOMS has accumulated a long-term data record since 1979, detailing the huge plumes of dust covering India, the Middle East, the Sahara, and over the Atlantic Ocean all the way to the Caribbean and into Florida. Similar observations have been made for the massive annual fires over Africa, South America, and northern Canada.
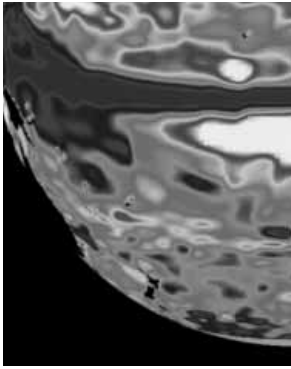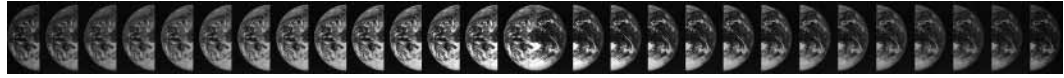
For more information, visit: http://jwocky.gsfc.nasa.gov

30 SEP 97

Scale represents smoke density.

5 OCT 97
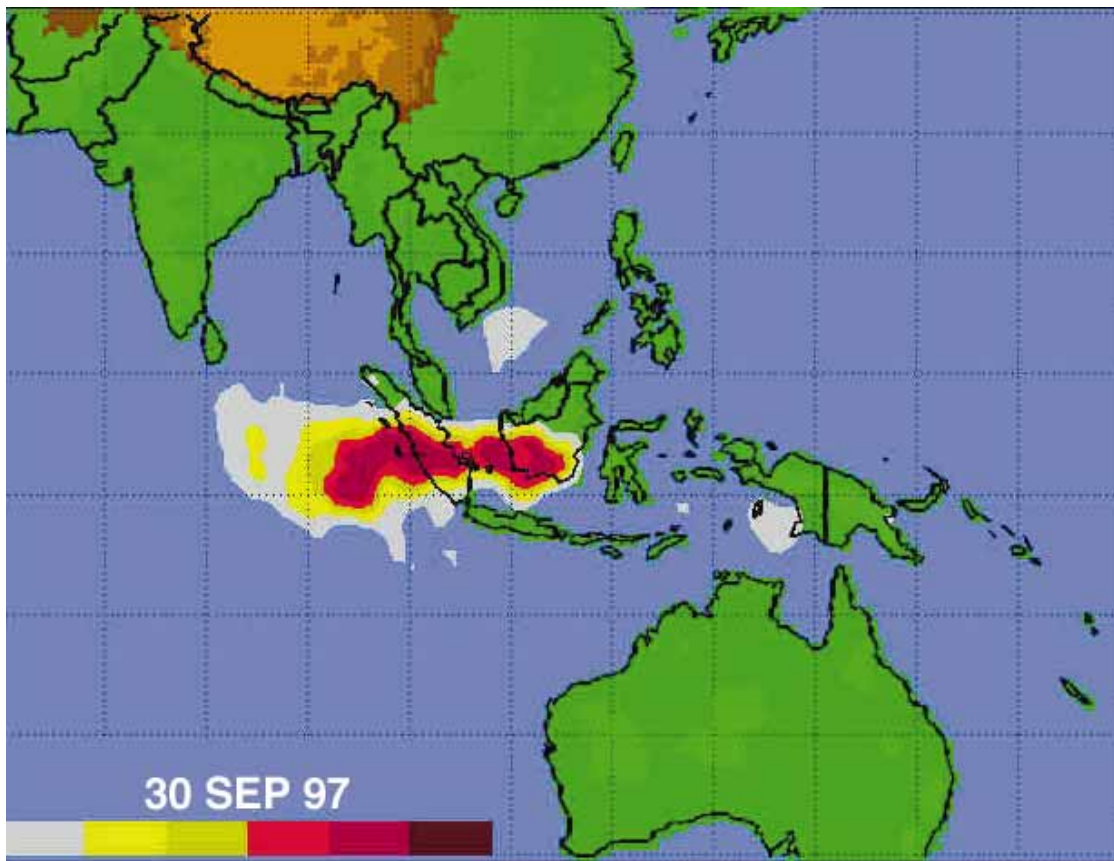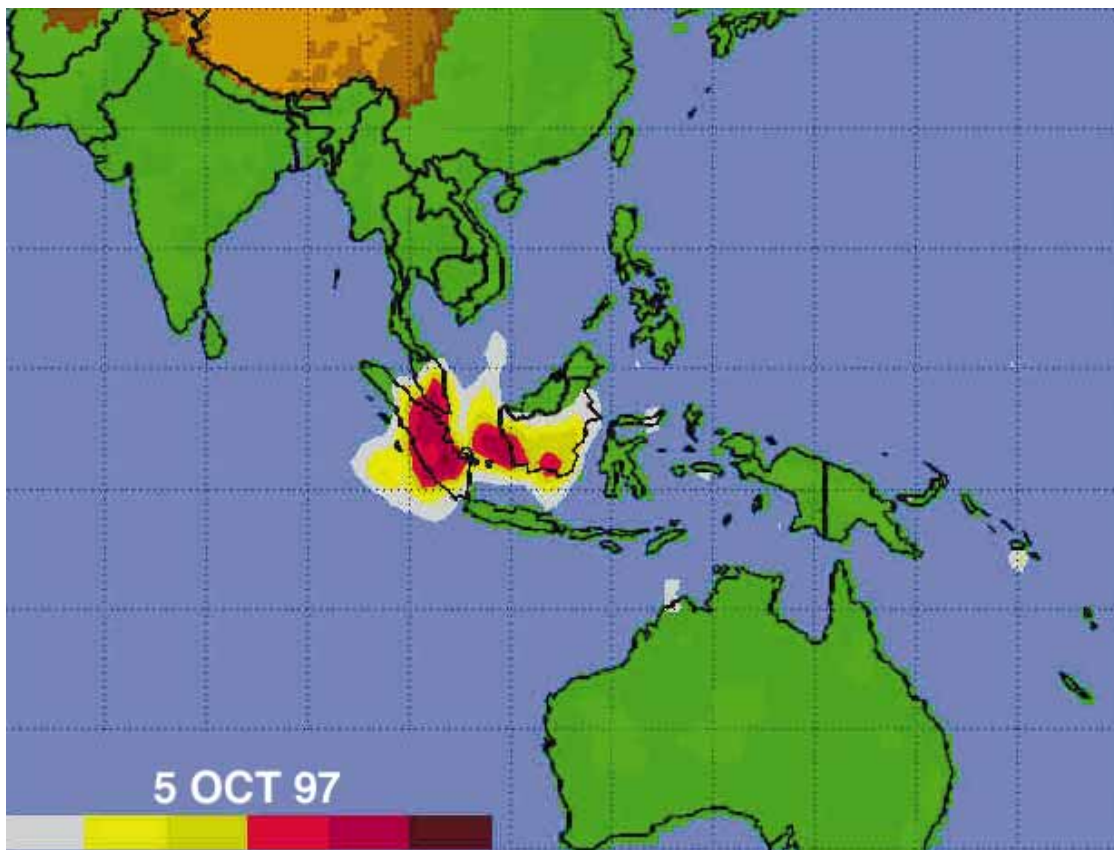
Scale represents smoke density.

Forecasting EL NIÑO 1997 with TOPEX/POSEIDON Ocean Satellite Data

User Need:

The weather-disrupting El Niño phenomenon allows a large mass of warm water that is normally located near Australia to move eastward along the equator until it reaches the coast of South America. The displacement of so much warm water affects evaporation, where rain clouds form and, consequently, alters the typical atmospheric jet stream patterns around the world. El Niño events often cause heavy rain and flooding in California and the states around the Gulf of Mexico, unseasonably mild winters in the northeastern United States and severe droughts in Australia, Africa and Indonesia. The 1982/83 El Niño caused $8 Billion of economic losses worldwide. The early forecast of 1997's El Niño may save billions of dollars and human lives worldwide.

Product:

In spring 1997, the National Center for Environmental Prediction (NCEP) of the National Oceanic and Atmospheric Administration (NOAA) issued a strong El Niño advisory earlier than ever before. TOPEX/Poseidon satellite altimetry data, which have been used by NCEP for its routine long-range weather forecast since March 1997, have improved this predictive tool. This was the first official El Niño forecast that used TOPEX/Poseidon data in conjunction with limited regional measurements from buoys and ships in NCEP's forecasting model of the ocean-atmosphere system.

Since winter 1997, high-resolution TOPEX/Poseidon data have become available in near real-time, thanks to high precision orbit data from the Global Positioning Satellite (GPS) system and improved data processing. This has expedited the production of TOPEX/Poseidon image maps for tracking El Niño signals in the Pacific Ocean. The first signs of the 1997 El Niño were seen in maps of TOPEX/Poseidon sea surface height data in spring 1997. During May, images that showed "the birth" of El Niño in the equatorial Pacific Ocean was released to the public. TOPEX/Poseidon images documented the onset and growth to "full-blown" El Niño condition with a series of images released to the public. In these figures, red and white areas indicate unusual patterns of heat storage; in the white areas, the sea surface is between 14 and 32 centimeters (6 to 13 inches) above normal; red areas are about 10 centimeters (4 inches) above normal. Throughout fall, the surface area covered by the higher-than-normal water was over one and one-half times the size of the continental United States.

Utility/Benefit:

Our ability to provide regionally useful seasonal and annual forecasts in North America enabled NOAA to issue an El Niño advisory for the 1997–98 winter season, which California used to equip its emergency preparedness staff for the anticipated storms and flooding. Agricultural communities throughout impacted regions are adapting their crops to either drought-resistant varieties (Indonesia, northern Australia and Africa) or flood-resistant varieties (California, Mexico, the Midwest U.S.).
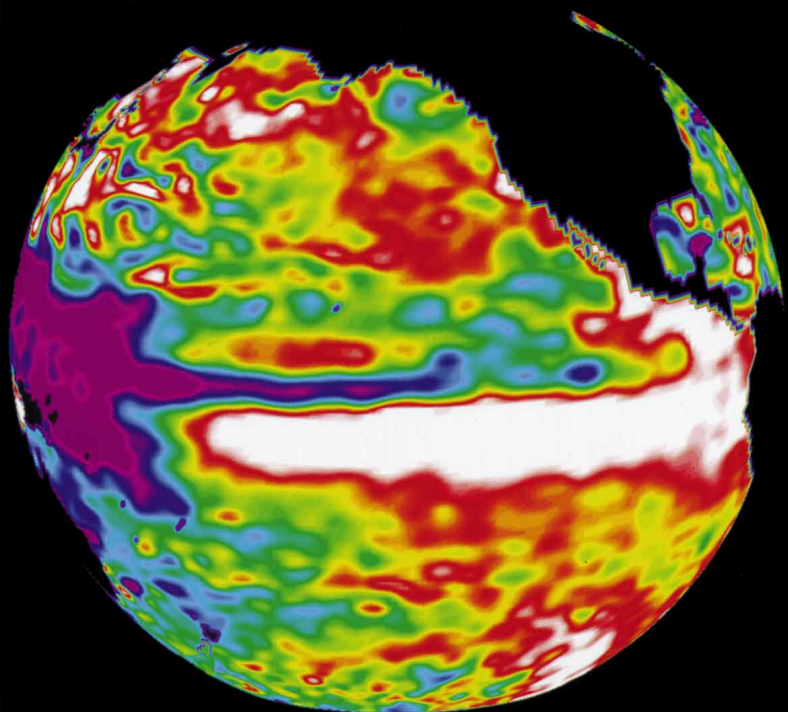
For more information, visit: http://www.jpl.nasa.gov
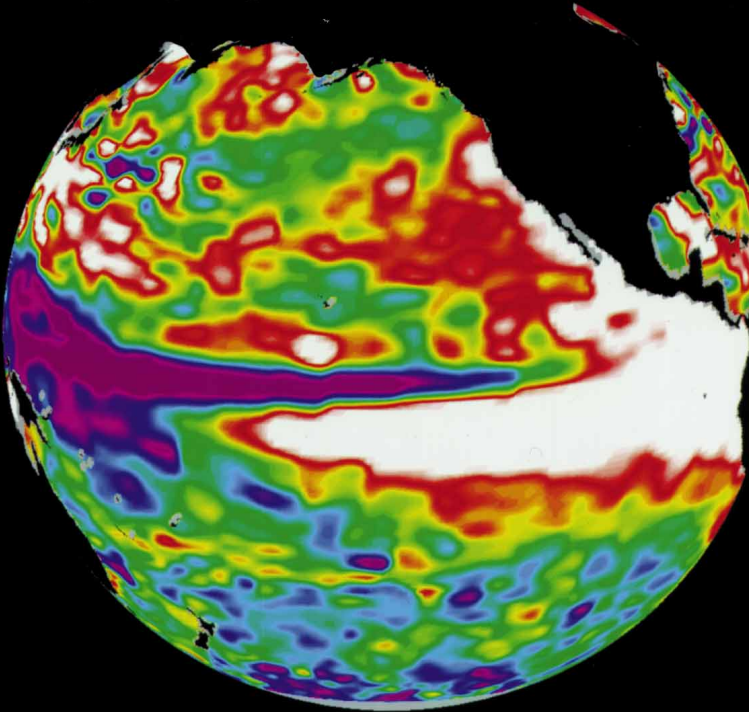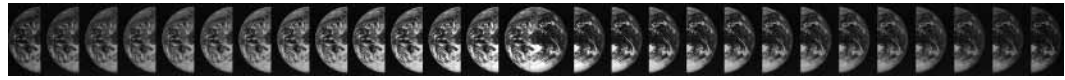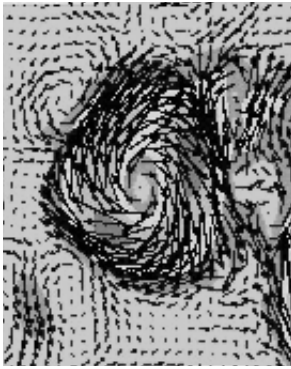
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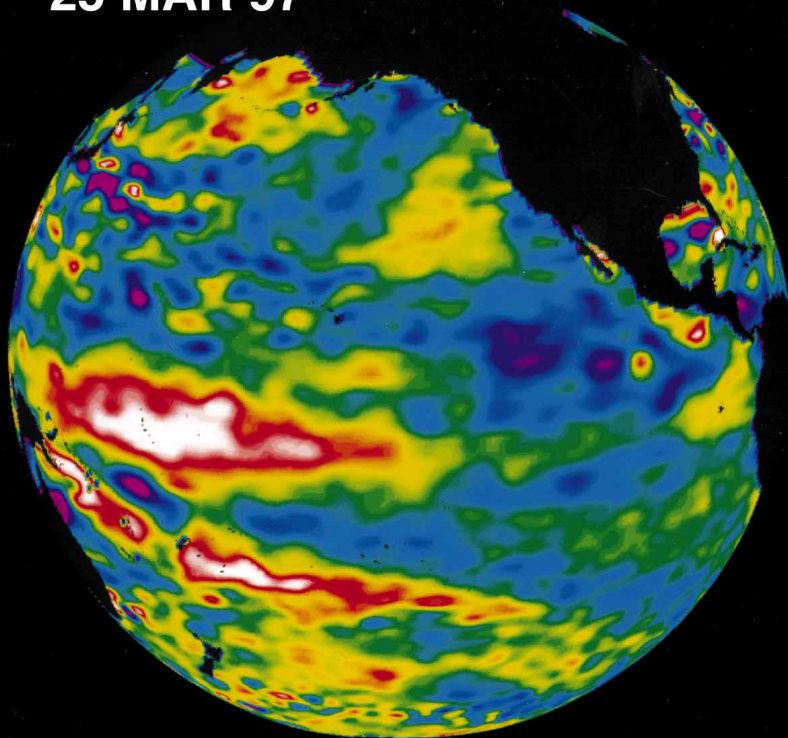
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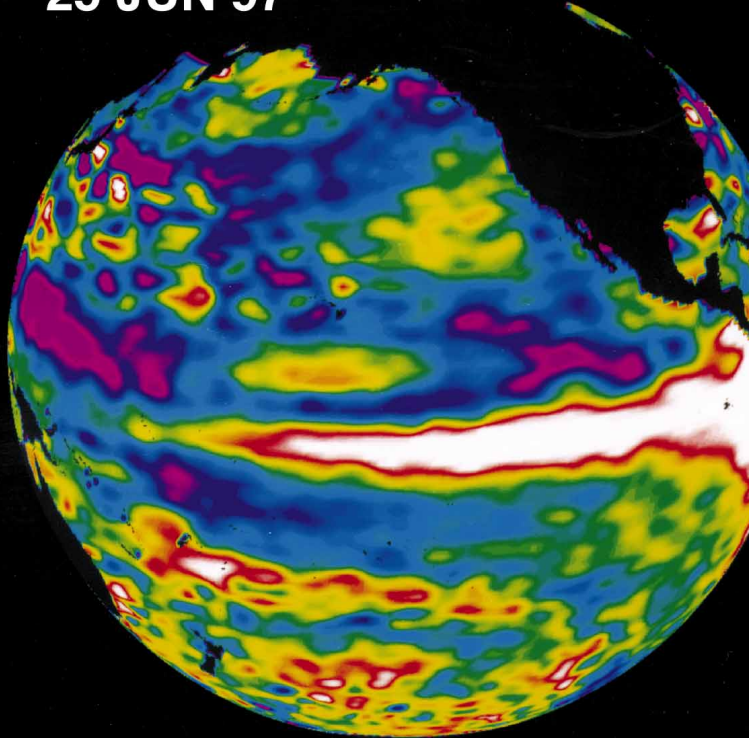
20 SEP 97

10 NOV 97

A "Nowcast"/Forecast System for the Gulf of Mexico

User Need:

Offshore oil production and exploration are being undertaken in ever-deeper waters in the Gulf of Mexico. This exposes these operations to the Loop Current (LC) and the strong swirling eddies (with speeds of 2–4 knots or about 1–2 meters per second) that are shed off from it. These eddies, once shed, move into the western Gulf at speeds of a few kilometers a day, often along a path that directly impacts offshore oil operations. In the past, economic losses for incorrect weather decisions in the Gulf cost $250,000 per day for a modern drilling ship, when platforms were unnecessarily shut down.

Product:

The top panel shows the "nowcast" made on 26 October 1997 with assimilation of TOPEX and ERS-2 satellite data into a comprehensive model of the Gulf. Currents at 50 meters depth clearly show eddy "El Dorado" centered at 26°N / 89°W. This eddy was shed northwest from the LC. The TOPEX/ERS-2 tracks for the previous ten days are superimposed to show the spacing of data that was assimilated into the model. The bottom panel shows the two-week forecast made from this "nowcast," which predicted Gulf conditions for 9 November 97. In this forecast, eddy "El Dorado" has a slightly different shape and a distinct loop-like feature has developed north of the LC.

Utility/Benefit:

Drilling activities cannot proceed in currents stronger than 2 knots (about 1 meter per second), because of the difficulty in dynamic position-keeping as well as the stresses imposed on the drill pipe itself as it extends through the water column. Thus accurate prediction of currents at the drill site is useful for advance planning of operations as well as shutting down operations in time. Shutdown of routine operations on a production platform can itself cost several tens of thousands of dollars in lost production, but may sometimes be necessary to avoid risking spills of drilling muds and oil into the Gulf of Mexico.

For more information, visit: http://shaman.colorado.edu/research

**CCAR
University of
Colorado**

(J.–K. Choi and
L.H. Kantha)

top:

Model Run
26 October 1997
at 50m depth

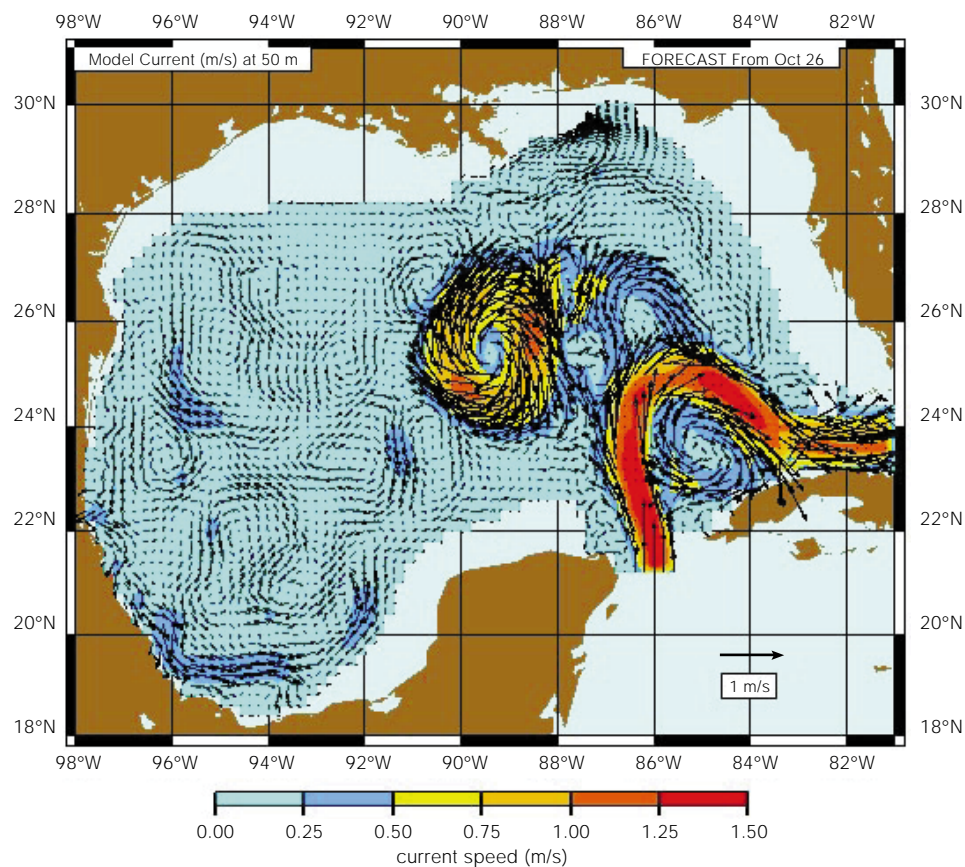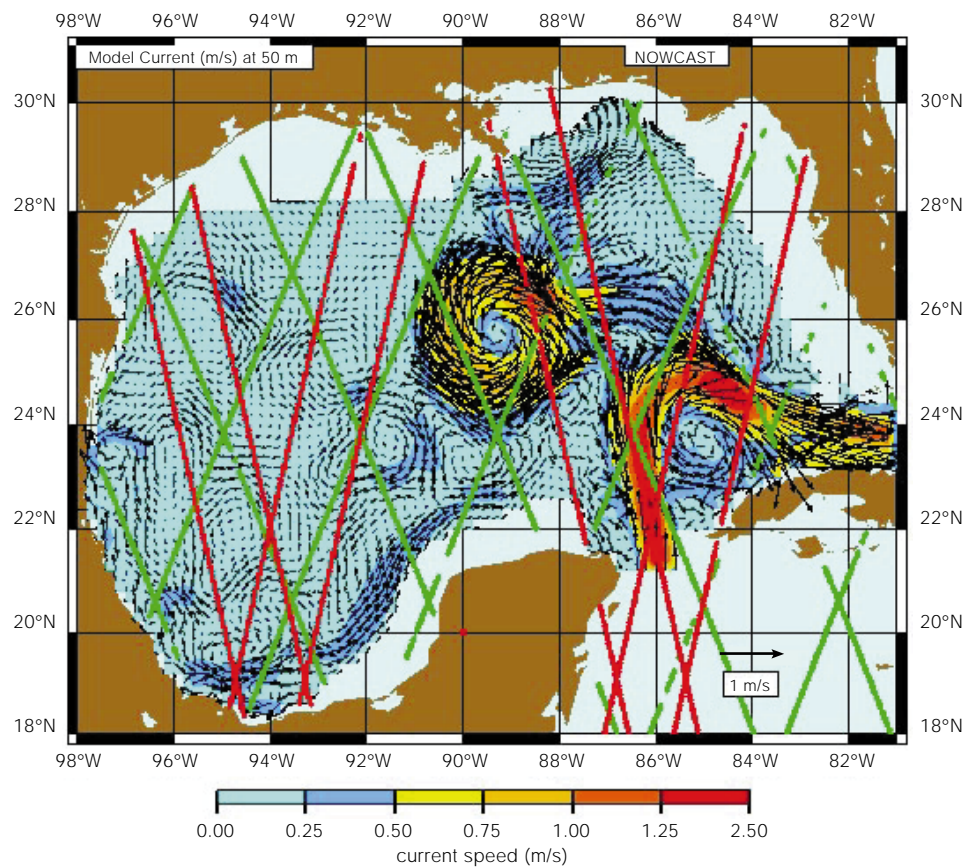10-day
TOPEX/ERS-2
tracks are shown.

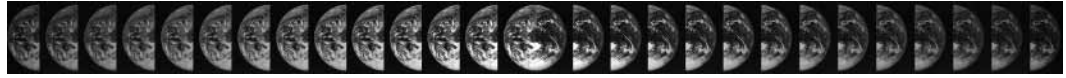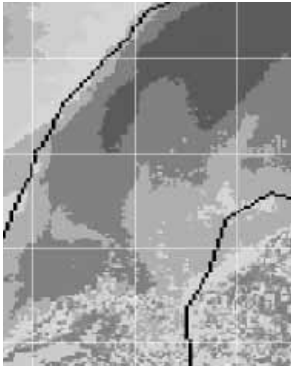Green: TOPEX
Red: ERS-2
Black: XBT

below:

Model Run
9 November 1997
at 50m depth

Current-day
TOPEX/ERS-2
tracks are shown.

Green: TOPEX
Red: ERS-2
Black: XBT

Satellite-Derived Sea Surface Temperature Maps for the Sport Fishing Industry

User Need:

Sea Surface Temperatures and the locations of currents around the North American coasts are important to the sport fishing and maritime industries. The Kansas Applied Remote Sensing (KARS) Program at the University of Kansas has developed a system for monitoring coastal sea temperatures and currents around North America using 1 km resolution satellite data. These data are used to produce daily Sea Surface Temperature (SST) maps. The imagery used for this product is acquired through the KARS AVHRR ground-receiving station that was funded by NASA's Earth Science Enterprise program.
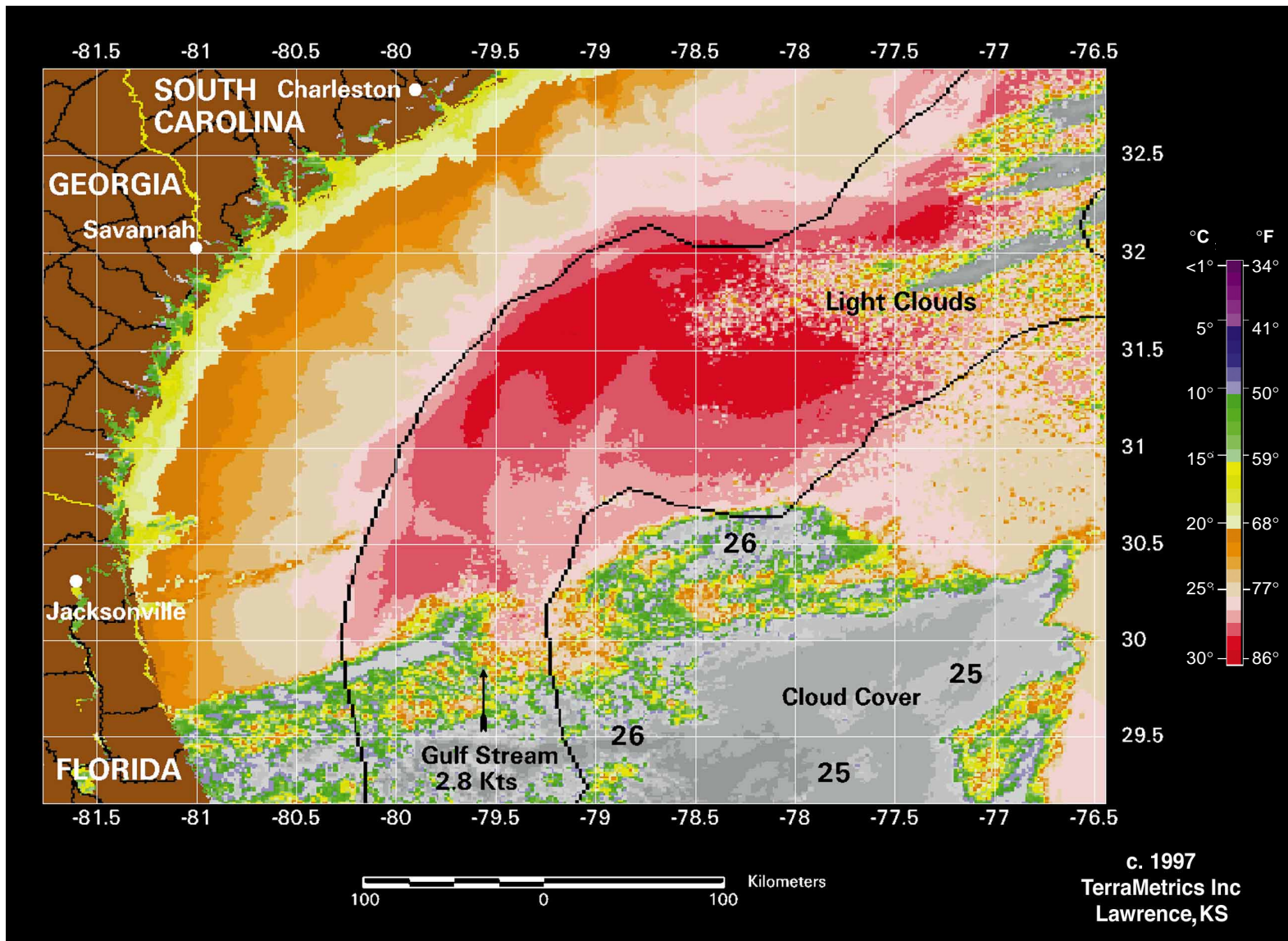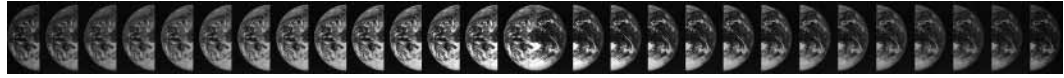
Product:

The SST maps display water temperatures at 1°C intervals, and illustrate the locations of currents and eddies. The product is further enhanced by the addition of Gulf Stream temperature boundaries and numerical SST values whenever cloud cover obstructs the ocean surface. This data is acquired from the Naval Oceanographic Data Distribution System. The SST products are marketed as part of a maritime package by Data Transmission Network (DTN), of Omaha, NB. The package includes weather information and sea condition forecasts provided by WeatherExpress Inc., of Omaha, NB. Shown is a map of the U.S. southeast coast with enhancements.

Utility/Benefit:

Charts that show sea surface temperatures and currents can be effectively used to identify potential areas of great fishing. Sea Surface charts show temperature boundaries, water movements (i.e., the Gulf Stream), currents and temperature "pockets". These visual attributes can then be used along with knowledge about fish types to locate areas that have a high potential for fish concentration. Timely identification of these natural boundaries can lead to better fishing success by saving the time and the fuel needed to locate the best fishing sites.

For more information, visit: http://www.kars.ukans.edu

SOUTH
CAROLINA   Charleston ●

GEORGIA

Savannah ●

Jacksonville ●

FLORIDA

Light Clouds

26

Cloud Cover

25

26

25

Gulf Stream
2.8 Kts

-81.5 -81 -80.5 -80 -79.5 -79 -78.5 -78 -77.5 -77 -76.5

32.5
32
31.5
31
30.5
30
29.5

°C	°F
<1°	34°
5°	41°
10°	50°
15°	59°
20°	68°
25°	77°
30°	86°

Kilometers
100   0   100

c. 1997
TerraMetrics Inc
Lawrence, KS

WorldWinds: Satellite-Derived Marine Wind and Wave Forecasts for Commercial Television Weather

User Need:

As the television weather viewing public becomes more sophisticated, it requires more innovative, informative and accurate weather information, especially for viewers who have interests in near shore and offshore marine operations. Marine winds can now be measured and displayed graphically for television broadcast along the coastal U.S., which has led to improved marine operations for both recreational and commercial boaters, fishermen, coastal shipping and off-shore oil and gas operations, and search and rescue operations.

Product:

Supported by NASA's Stennis Space Center, User Systems Inc. (USI) has teamed with 4 weathercaster business partners to assist in the development and evaluation of WorldWinds products for meteorological accuracy and local area application effectiveness. The cooperating partners are: WWL-TV4 in New Orleans, LA; WRC-TV4 in Washington, D.C.; WCPX-TV6 in Orlando, FL; and WAVY-TV10 in Norfolk, VA.

USI has developed an animation product of daily satellite-derived global marine wind observations and forecasts. Displays of storm surge information for coastal locations, and U.S. Navy ocean wave heights are also available, along with static images depicting wind speed and direction.

USI has built an operational production system that merges wind data from the instruments listed in the following paragraph into a single data file. These data files are then made available to its customers via its Web site. USI maintains a full historical archive of all observed data.
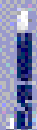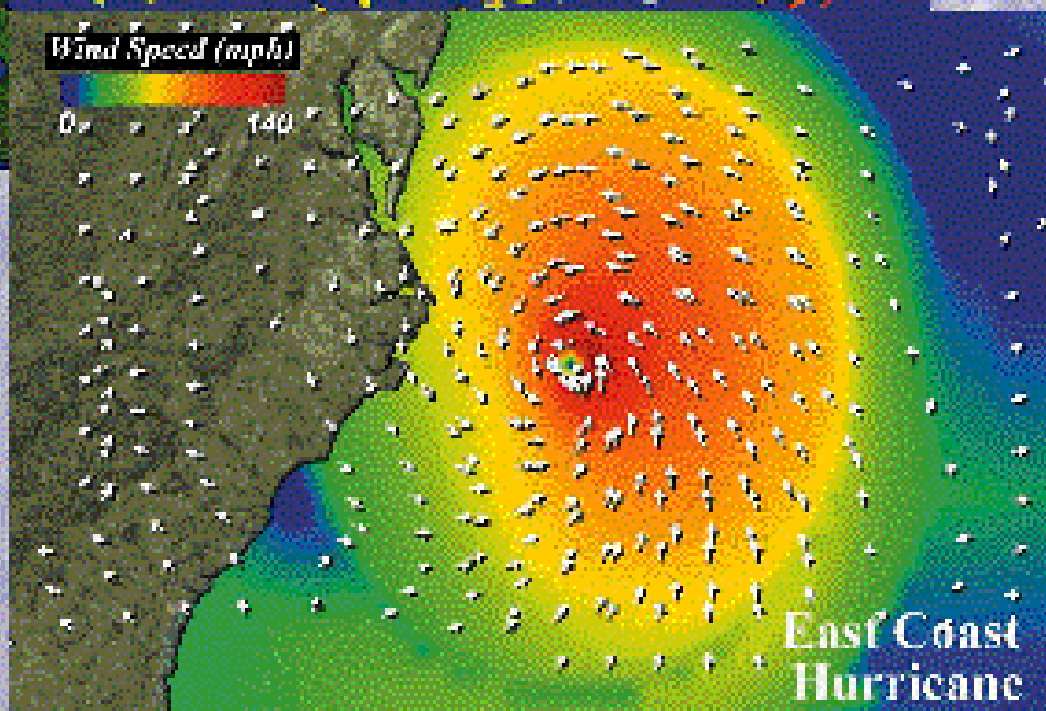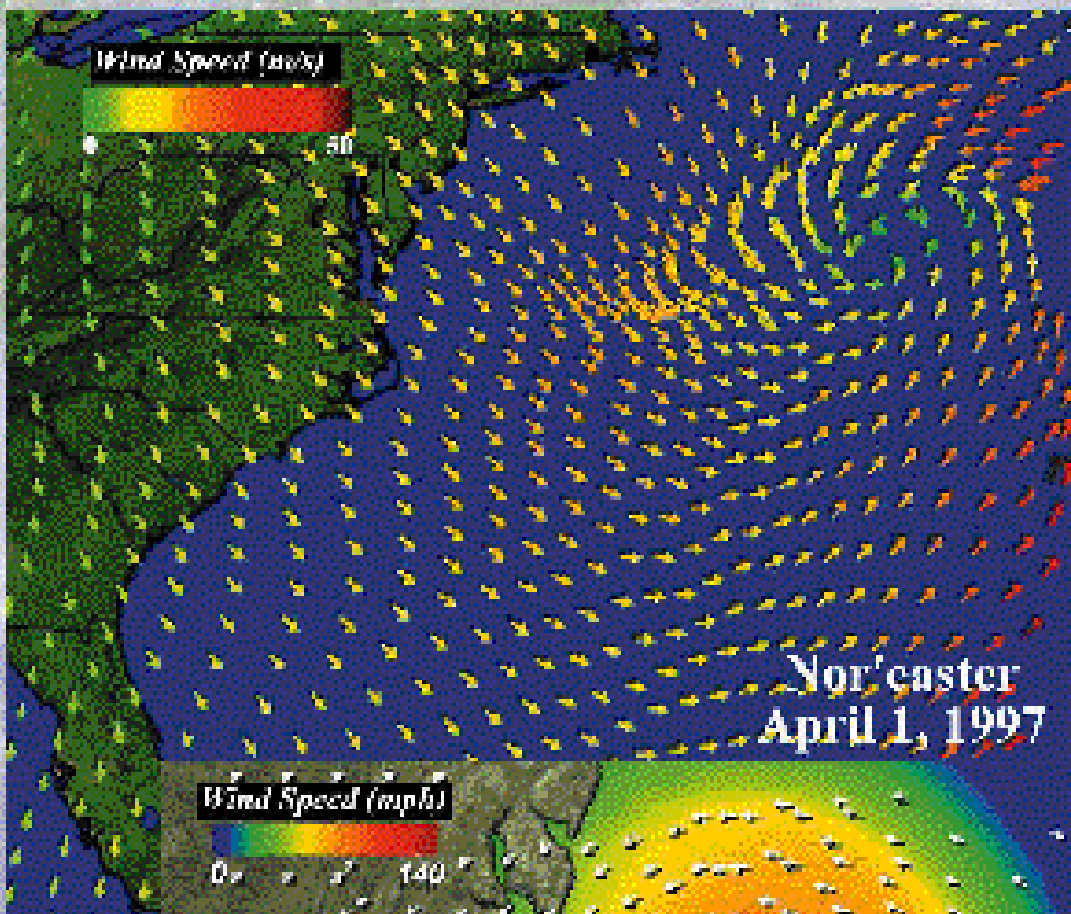
Utility/Benefit:

WorldWinds marine wind analyses and forecasts advise TV viewers of several weather conditions (hurricanes, nor'easters) as well as offshore marine wind conditions of interest to commercial and recreational boaters. WorldWinds users realize cost and time savings through increased safety in all areas of marine operations. The offshore oil industry uses improved forecasts of marine wind and wave conditions at offshore sites to aid in scheduling platform transits, resupply trips and crew transfers. In addition, WorldWinds products enable commercial vessels to follow safe and fuel-efficient transits on the world's oceans by avoiding severe weather and adverse sea conditions.
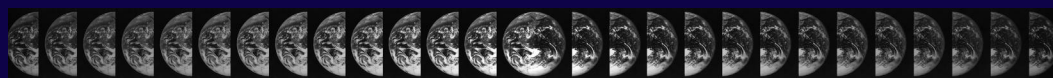
Use of WorldWinds products by the television stations along the coastal U.S. lead to an increase in viewing audience, and thus increased ratings. Marine transportation interests utilize accurate wind data to aid in the determination of optimum ship routing.

For more information, visit: http://www.crsp.ssc.nasa.gov

WORLDWINDS™ Sample Products

Wind Speed (m/s)

50

Nor'easter
April 1, 1997

Wind Speed (mph)

0   70   140

East Coast
Hurricane

USER SYSTEMS ENTERPRISES, INC.

For more information about NASA's Earth Science Enterprise:

Earth Science Enterprise

Code YM
NASA Headquarters
Washington, DC 20546

World Wide Web URL: http://www.hq.nasa.gov/office/mtpe

Public Inquiries

Code P
NASA Headquarters
Washington, DC 20546

EOS Project Science Office

Code 900
NASA/Goddard Space Flight Center
Greenbelt, MD 20771

World Wide Web URL: http://eospso.gsfc.nasa.gov/eospso_homepage.html